Health management system for the diabetic patient through body area network

Kundan K.Thakur, Lintu A.Varghese and Swati R.Khokale

Department of Information Technology, Sandip Institute of Technology and Research Centre, Mahiravani, Nasik, 422213, Maharashtra, India.

ABSTRACT

Wireless body area sensors network technology provides efficient communication Solution to Omnipresent health-care system. Here the system is taking care of diabetes patient through the WBASN even when the patients is mobile and preserving his all test reports and prescribed medicine at server side .This system provide early detection of abnormal condition and prevention of acute consequences as well as ECG of the patient. The produced android application send alert message with his present location to the doctor as well as family simultaneously if there is any sudden fluctuation in patients body.

Introduction

The World Health Organization predicts that chronic diseases will become the most expensive problem faced by current health care systems and sees the integration of prevention into health care as the main solution for this problem. A paradigm shift towards integrated, preventive health care as well as equipping patients within formation, motivation, and skills in prevention and self-management are described as Essential elements for solving this problem. As body sensor network (BSN) systems are capable of continuously monitoring a person's physiological structure. Now a days wireless sensors are most widely use in medical applications. Because it provide better quality of health care to patient than the wired sensors. For example, patients equipped with a wireless body area network (WBAN) need not be physically present at the physician for their diagnostic. It is helpful in immediate treatment. Healthcare is always a big concern, since it involves the quality of life a given individual can have. The aging population of developed countries present a growing slice of governments budget, and presents new challenges to health care systems, namely with elderly people living on independent senior housing. At this point of time doctors have to treat or monitor a patient individually. The Nurse or doctor has taken care of the all patient's in the ward all the time. This is the biggest problem that doctor or nurse can't be present at the patient side 24*7.Most of the time doctors cannot access the proper condition of his patient ,when the patient is mobile .One more thing that the patient details are manually recorded so it can be lost. So we need to develop a System which will give us a dynamic monitoring of the patient and that thing can be achieved from the wireless body area sensor network. There are many diseases are emerging in our society. Diabetes is one of the dangerous disease in our society. Diabetes take human being life slowly. According to WHO report till today 347 million people died because of diabetes and they project that till 2030 diabetes will be the 7th biggest cause of the death. Diabetes is a complex group of diseases with a variety of causes. People with diabetes have high blood glucose; also called high blood sugar Here is a list of the most common diabetes symptoms:

• Frequent urination
• Disproportionate thirst
• Weight gain
• Unusual weight loss
• Blurred vision
• Cuts and bruises don't heal properly or quickly
• Itchy skin
•Frequent gum disease/infection

Fig 1. Symptoms of Diabetes

If not controlled, Diabetes can put you at risk for a host of complications that can affect nearly every organ in the body. They include:
• The Heart and blood vessels
• The eyes
• The kidneys
• The nerves
• The gums and teeth

Heart disease and blood vessel disease are the biggest complications that people with uncontrolled diabetes face. In 2004, approximately 68.So here for the diabetes patient we want to make system which will help them to fight with the disease .In this system we all try to manage the patient data and his all

Tele:
E-mail addresses: kundanthakur5@gmail.com

test reports and for the dynamic monitoring, we are going to use wireless body area sensor network This applications of wireless sensor networks allow in-home assistance, smart nursing homes, clinical trial and research augmentation. In-home health care becomes mandatory for diseases like Diabetes, providing memory enhancement through medicine reminders, mental stimulation through sounds or images of objects location, control over home appliances, medical data lookup, and emergency situations. Such approach may lead to a multi-tiered architecture, with lightweight mobile computers and smart sensors in conjunction with more powerful computational devices. Before describing and surveying medical applications for health care, this section focuses on several challenges and general aspects that characterize this kind of technologies.

Many WBASN based project concentrating on monitoring on the particular diseases. They making smart ward system by saving time, from the daily check-up routine .Due to the sensors attach on the body there is no need of regular checkup monitoring. We focus on preventive health care and present a system that helps to reduce a person's physical inactivity which is one of the risk factors of many costly and disabling health conditions [4].

Related work

Here the corresponding author proposed system that utilizes phone based accelerometer for detection user walking ,jogging, Climbing stairs, sitting and standing. The corresponding system will endorse the real time identification. Three different kinds of motion-band sensors are attach on the body of persons like hip , wrist, ankle provide accelerometer, magnetometer, and gyroscope measurements to the users phone via Bluetooth. By producing activity identification system on a cell phone huge amount of users can be collected. Labeled accelerometer data from several users were collected in this identification system[4][5]. In the system , they have used combination of five accelerometers and one heart rate sensors. This combination not only allows the identification of the exercise but also the intensity of them. To recognize the intensity of the exercise, they have used the heart rate sensors. In the given paper, the author present comparison between the two approaches for each, Detecting and counting the Weight lifting exercise [1],[4],[5].

The typical scenarios of WBASN are used for the various applications rather than to help the over the hills people like this can used for the patients with chronic disorders. While this can used as smart wards means it will reduce the time for routine check-up and real time monitoring. It will also help in the emergency of the patients. Here they presented Evaluation of ECG home health monitoring using the developed TRG(it is some kind of electronic motes)[4],[1],[5].

Fig. 2 Sensors bounded Person during the Exercise
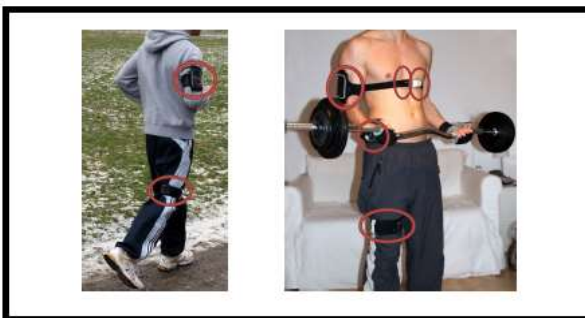
There is also SPINE framework available in WSN.SPINE (Signal Processing In-Node Environment) is an open source domain-specific framework Implemented to assist flexible and distributed signal- processing for wireless body sensor network

systems. The main motto of SPINE to Assist the WBASN developers through the rapid prototyping of signal processing. There are several advantages of using a SPINE emulator for instance, processing functionalities [3]. There exists various classes of health sensor systems, including health care and fitness related systems highlighted below.

Health Care Related: There are a range of systems that examine remote monitoring system for healthcare applications. There are systems used for rehabilitation and those use for modifying diet . Other applications use proprietary or in house sensors to monitor gait ,biomarkers for cancer patients , biomarkers for heart failure patients, and other general health parameters[2],[9].

Fitness related and activity monitoring: With fitness application, remote monitoring system has included the interval training systems, including those that use adaptive techniques to tailor workout. There are also a wide range of papers that examine activity monitoring and classification, including those that use accelerometers on smart phones [2],[9].

System Level Issues: Some also consider system-level issues such as middleware or power minimization. There has also been an examination of networking issues, specifically with body area networks [2], [9].

System and mathematical foundation

In this system , we are going to take care of the diabetes patient. Normally diabetes patient has to suffer from many phases of problem. After detection of Diabetes, he has to go through several different kind of tests and he have to take the prescribed medicine on daily basis and if he forgot to take any medicine then he has face its upshots. So In our system we are going to complete management of the patient through
• Web base application
• Android application
• Sensors
-Heart monitoring sensors
-Pulse count sensors
-Temperature monitoring sensors
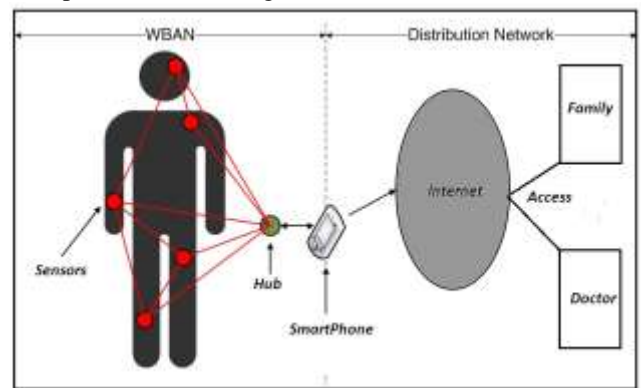-Blood pressure monitoring sensors

Fig 3. Person With Sensors and The data Access

After detection of diabetes, when patient goes to doctor at first doctor will do his registration on the web base and give him User-name and password. After prescribing the medicine to patient, doctor will do the all entries of medicine to the patient account in web base application and call him for the next visit. At the time of taking the insulin injection , the application will automatically alert the patient .Before one day of next visit, application will again alert the patient about his next visit here the patient has two choices weather to go to the hospital and do the test or do the test by himself .Sugar test will done by the patient himself and then he will put all the readings to the web

base application and all other test will be automatically performed by the sensors which are we going to use.

Now consider the patient is out of the home, there is some fluctuation with his heart rate or blood-pressure .the below diagram will show the exact working of the system
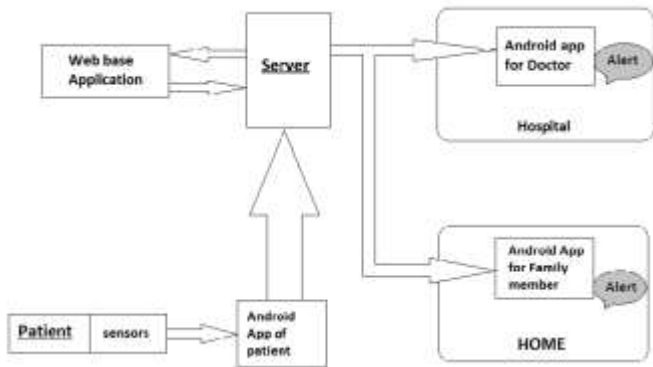

Fig 4. Dynamic Detection through Sensors

• After the sudden fluctuation, all the sensors will gather all the information from the body like body temperature, blood pressure, pulse count, heart rate which will directly give us the ECG of the patient and send it to the smartphone of patient through the Bluetooth.

• Then smartphone will send all the all the data to the server by internet and it will stored with desired date.

• Then the server will send alert message with the patient location to the patient family as well as doctor through the smartphone application. So they can take care of the patient as soon as possible

Mathematical model

• Patient: P
• Doctor: D
• Hospital: H
• Family: F
• Medicine: M
• Test Report: TR
• Sever: S
• Call Next Visit: Call
• Blood pressure: BP
• Pulse Rate Sensors: PS
• Temperature Sensors: TS
• Electrocardiogram: ECG
• Glucose level Test: GT
• Mobile App: MA
• Location: LOC

Step 1

Patient will go to the doctor, here doctor will perform all the test and upload It to the server, then he will prescribe him medicine that also upload at server

Goto (P, H)

∃ D(Doctor(D)) → Check(Patient(P))
∃ D(Doctor(D)) → Prescribe(M,P)
∃ D(Doctor(D)) → Store(TR,S)
∃ D(Doctor(D)) → Store(M,S)
∃ D(Doctor(D)) → Call(P, Date)
∃ D(Doctor(D)) → Call(P,Date)

Step2 : Before one day , Patient directly get Appointment message with the time and Date

∃ P(Patient(P)) → Get(Message)

Step3 Here patient have to choices either to go to Doctor, perform all the test OR to do the self-test by sensors at home

Follow the step 1 OR

∃ P(Patient(P)) → Test(GT)
∃ P(Patient(P)) → Store(GT,S)

∃ (MA)(MobileApp(MA))→ get(BP)
∃ (MA)(MobileApp(MA)) → get(PS)
∃ (MA)(MobileApp(MA))→ get(TS)
∃ (MA)(MobileApp(MA))→ get(ECG)
∀(TR)(MobileApp(MA)) → Send(TR,S)

Step4 Now consider the person is outside and if there is any sudden fluctuation then the sensors will send all the data to the server with Alert message and the location of patient.

(BP ∨ TS ∨ PS) > Critical Reading

∃ (MA)(MobileApp(MA))→ get(BP)
∃ (MA)(MobileApp(MA)) → get(PS)
∃ (MA)(MobileApp(MA)) → get(TS)
∃ (MA)(MobileApp(MA)) → (ECG)
∀(TR)(MobileApp(MA))→Send(TR,S)
∃ (MA)(MobileApp(MA))→ Alert(S)
∃ (MA)(MobileApp(MA))→(LOC(P),S)
(Server,(S)) → Send(Alert(Message),F ∧D)
(Server,(S)) → Send(LOC(P),F ∧D)

Venn Diagram

• P : Patient
• D : Doctor
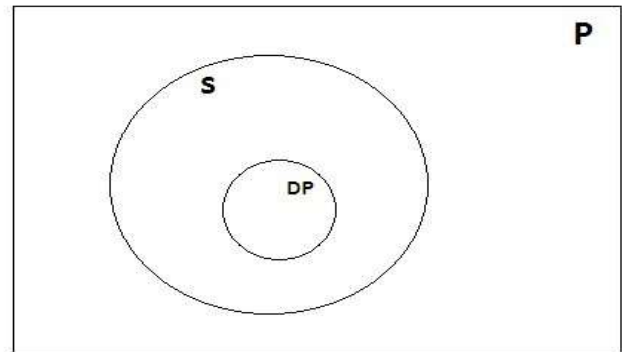• U : Universal
• DP : Diabetes Patient

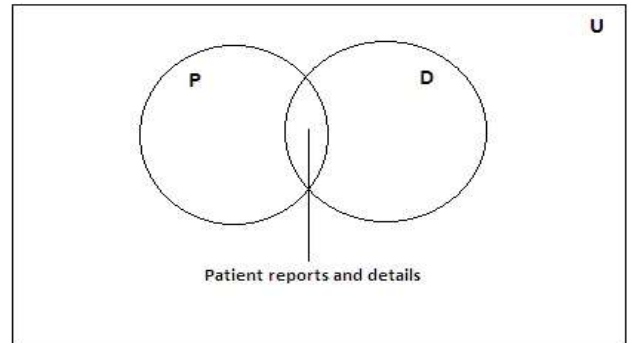**Fig 5. Diabetes patient bounded with sensors for the dynamic monitoring**

Fig 6. Doctor will check the patient and stored his all the test reports and medicine to the server

Challenges

Power challenges:

Many wireless sensor devices are battery operated; therefore challenge is present in every application of WBASN. Typical alkaline battery provide 50 watt hours of energy. So every time we need to change the battery that increase the cost of the system.

Material constraints:

Every sensor is placed on human body .So it may cause skin disease, if the person has some kind of allergy.

Memory retention:

Due to low power as well as memory, the sensor cannot store more amounts of data.

Conclusion

The development of Body area network is enlarging a new way of dynamic monitoring of the patient. This new technology is providing a new way of patient care through the different kind of sensors on body. Information, communication, Management are the key elements of the body area sensor network .All the information is gathered from the provided sensor's on-body and the communication is done by Bluetooth or WIFI for the management purpose of the patient. Diabetes care system, Provide the Proper management of the diabetes patient. Through this system patient can take his medicine and the Insulin on up-to date basis. Due to the dynamic monitoring of the patient, in emergency case we can save the patient's life by taking necessary actions on that moment. So from this system, we can save the diabetes patient from the disability as well as save the precious human life.

Future scope

Wireless body area sensor network is very useful for monitoring various activities of the body. In future they can be used by
• Sports Person for measuring various body parameters during sports
• Firefighter or policeman
• In military environment
• Health monitoring for animals
With Some modification in the system we can also make new system's for another vital diseases like:
• Cardiovascular diseases
• Asthma
• Cancer Detection
• Preventing medical accidents
• Alzheimer, depression, and elderly people monitoring
• Epileptic Seizures Strike Early Warning

Acknowledgement

References

[1]ChritianSeeger, KristofVanLaerhoven, and Alejandro Buchmann, "MyHealthAssistant: An Event-driven Middleware for Multiple Medical Applications on a Smartphone-mediated Body SensorNetwork",2013

[2]PervezKhan,Md.AsdaqueHussain,KyungSupKwak,"Medical Applicationsof Wireless Body Area Networks", 2009..

[3]Raffaele Gravina , Andreoli Alessandro , Alessia Salmeri , Luigi,Buondonno,NikhilRaveendranathan,VitaliLoseu,"Enablin gMultipleBSNApplicationsUsing the SPINE Framework", 2010

[4] Rozeha A. Rashid , Mohd Rozaini Abd Rahim, S. H. Syed Arifin, S.K. Syed Yusof, Norsheila Fisal, "Wireless Biomedical Sensor Network for Home-based ECG Monitoring", 2008.

[5]ChristianSeeger,AlejandroBuchmannKristofVanLaerhovenm y,"MyHealthAssistant: A Phone-based Body Sensor Network that Captures the Wearers Exercises throughout the Day", 2011.

[6]JavedAhmad1,FareehaZafar,"ReviewofBodyAreaNetworkTe chnologyWireless Medical Monitoring", 2012.

[7]JatinderSinghandJeanMBacon,"Onmiddlewareforemerginghe althservices", 2013.

[8] Jess Rodrguez Molina , JosFernn Martnez, Pedro Castillejo andLourdesLpez,"CombiningWirelessSensorNetworksandSema nticMiddleware for an Internet of Things Based Sportsman/Woman Monitoring Application", 2013.

[9] Christian Seeger, Alejandro Buchmann Kristof Van Laerhoven, "An Event-based BSN Middleware that supports Seamless Switching between Sensor Configura- tions", 2012.

[10] Christian Seeger , Alejandro Buchmann Kristof Van Laerhoven, "Wireless Sensor Networks in the Wild: Three Practical Issues after a Middleware Deployment", 2011.

[11] Vinh Tran, "Remote Coach: A Remote Health Sensor Data Monitoring System", 2012.

[12] Aashima Arya , Naveen Biland, "A Review: Wireless Body Area Networks for Health Care", 2014.

[13] Garth V. Crosby, Tirthankar Ghosh , Renita Murimi , Craig A. Chin, "Wireless Body Area Networks for Healthcare: A Survey", 2012.

[14] Sana Ullah , Pervez Khan, Niamat Ullah, Shahnaz Saleem, Henry Higgins, and Kyung Sup Kwak, "A Review of Wireless Body Area Networks for Medical Applications", 2010.

[15] Sergio Gonza lez Valenzuela, Xuedong Liang, Huasong Cao, Min Chen, and Vic- tor C.M. Leung, "Body Area Networks", 2012.

[16] J. Ryckaert, P. De Doncker, R. Meys, A. de Le Hoye and S. Donnay, "Channel model for wireless communication around human body", 2004.

[17]LingfengLiu,RaffaeleDErrico,LaurentOuvry,PhilippeDeDon cker,andClaude Oestges, "Dynamic Channel Modeling at 2.4 GHz for On-Body Area Networks", 2012.

[18]BenotLatreBartBraemIngridMoermanChrisBlondiaPietDem eester,"ASurvey on Wireless Body Area Networks"

[19]PrathameshDinkar,AbhishekGulavani,SourabhKetkale,Prati kKadam,Sheetal,Dabhade,"RemoteHealthMonitoringusingWirel essBodyAreaNetwork",2013.

[20] Arif Onder ISIKMAN , Loris Cazalon, Feiquan Chen , Peng Li, "Body Area Net- works", 2011.

[21]MayuriC.Navale,RameshwariT.Chavan,SandhyaM.Damare, RenukaS.Dube,Prof. Suhas M.Patil, "A Survey Paper on Body Area Network in Healthcare System", 2014..